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International Journal of Current Research
Vol. 7, Issue, 07, pp.17926-17929, July, 2015

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

RESEARCH ARTICLE

PULMONARY FUNCTION TEST IN PREGNANCY – A CROSS SECTIONAL STUDY

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ARTICLE INFO

Article History:
Received 21st April, 2015
Received in revised form
05th May, 2015
Accepted 24th June, 2015
Published online 28th July, 2015

Key words:
Pulmonary function test,
Pregnant women,
Different trimesters.

ABSTRACT

Introduction: Aim of this study is to compare the lung function variables, in different trimesters of pregnancy.
Materials and Methods: Pregnant women from the antenatal clinic of Government Hospital, Kilpauk Medical College, Chennai -10, were selected for this study. The study group consists of 107 women, of whom 18 women in the first trimester, 20 women in the second trimester, 45 women in the third trimester, and 24 women were in control group.
Result: Results showed FVC in all the three trimesters are less in comparison to controls. The decrease in FVC values is not statistically significant in first and second trimester but highly significant results were observed in third trimester when compared to controls.
Conclusion: FEF $_{25\ -75,}$ a small airway function showed a significant increase in first trimester pregnant women when compared to controls.

Citation: Dr. Santhakumari, U. Dr. Umayal, C.C. Dr. Gunavathy, G., 2015. "Pulmonary function test in Pregnancy – A cross sectional study", *International Journal of Current Research*, 7, (7), 17926-17929.

INTRODUCTION

Pulmonary function testing is one of the basic tools for evaluating a patient's respiratory status. In patients with suspected pulmonary disease it is often the first diagnostic test employed in the work up. The instrument used is spirometer. It measures how well the lung can exhale; it records the amount of air and the rate of air that is breathed in and out over a specified time. The information gathered during these tests are useful in diagnosing and quantifying certain types of lung disorders namely obstructive and restrictive lung diseases. Information regarding pulmonary functions in normal women during pregnancy is necessary for better antenatal care, in assessment of fitness for anesthesia and to evaluate the progress of pre existing lung disease. Although many of the principles of pulmonary function testing that date back a hundred years, are still in use recent years have seen as astounding multiplication of devices for assessing the various parameters of pulmonary function. Testing by means of electronic as well as mechanical apparatus has proceeded towards a rather specialized technology. The use of computers to perform spirometry has accelerated in the past decades. Validated computerized spirometry systems will simplify and enhance the measurement and interpretation of spirometry.

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Lung volumes play a major role in the gas exchange and in the work of breathing. Lung volumes are determined by the balance between the lungs elastic recoil properties and the properties of the muscles of the chest wall.

COPD is characterized by increase in lung volume and airway resistance and by decrease in expiratory flow rates. Emphysema, a specific type of COPD is further characterized by increased lung compliance. Restrictive lung diseases are characterized by decrease in lung volume, normal expiratory flow rates and resistance and a marked decrease in lung compliance. Alward *et al.* (Alward, 1930), found that the vital capacity although subject to wide individual variations usually remains essentially unchanged. But according to Saxena *et al.* (Saxena *et al.,* 1979), the vital capacity is decreased during third trimester along with the decrease in IRV and ERV. The PEFR decreases with advancing pregnancy which could be due to lesser force of contraction of main expiratory muscles like anterior abdominal muscles and internal intercostals muscles. Mokkapatti *et al.* (Mokkapatti *et al.,* 1991), in their cross sectional study of pregnant women have observed this decline, right from first trimester. Surekha *et al.* (Surekha *et al.,* 1984) in their study found that the maintained FVC, FEV_1% and MMEFR in spite of increasing uterine size and increasing blood volume could be due to the state of relative bronco dilatation which might be brought about by the smooth muscle relaxing action of certain hormones such as Progesterone, Relaxin and Corticosteroids.

A humoral factor alters the tracheobronchial smooth muscle tone so that pulmonary function is protected throughout pregnancy. Progesterone elevated in pregnancy influence the smooth muscle tone. Phatak *et al.* (Mrunal *et al.,* 2003) in their study found no significant change is observed in FEV_1% as during pregnancy, Progesterone, Corticosteroids and Relaxin cause certain degree of brochodilatation due to relaxation of smooth muscle. Thus the mechanical disadvantage to the respiratory apparatus induced by advancing pregnancy is compensated by decrease in air way resistance and an improved air way conductance. Cugel *et al.* (Cugell *et al.,* 1953) found that there was no significant change in FEVI/FVC. Similar findings were shown by Puranik *et al*. (Das *et al.,* 1991) and Chhabra et al. (Chhabra *et al.,* 1988) on their study found that MVV was lower in pregnant women that non pregnant women.

MATERIALS AND METHODS

Instrument used in the Study

The "MED SPIROR" was used for the study, The medspiror is a computerized pulmonary function testing equipment developed indigenously by "Med Systems" Pvt. Ltd. Chandigarh. Information entered regarding subject's age, sex height, weight, date, temperature. Two maneuvers were used to record all test viz.

Forced vital capacity (FVC) is the maximum volume of air that is breathed out by a rapid and complete expiration after a maximal inspiration. FVC is useful test to asses overall lung function. It is determined primarily by four factors (i) strength of the chest and abdominal muscles (ii) Airway resistance (iii) Lung size (iii) Elastic properties of the lung any condition that decrease the strength of the respiratory muscles (eg. Poliomyelitis) decreases the lung volume (eg. Tuberculosis), increases airway resistance (eg. Asthma or bronchitis) or conditions that make the lung stiffer will lead to significant decrease in FVC.

Functional parameters studied are (i) Forced vital capacity (FVC) in liters; (ii) Forced expiratory volumes (a)$FEV_{.5}$ in liters & $FEV_{.5}$ %(b)FEV_1 in liters & FEV_1 % (iii) Maximal voluntary ventilation (MVV) in liters/min. (iv) Forced expiratory Flow Rates in liters/Sec.(a)Peak Expiratory Flow Rate (PEFR) (b) FEF at 25% of FVC (FEF_{25}) (c) FEF_{50} FEF_{25-75}; (e)FEV_1/FVC% From a FVC determination, we can readily measure FEV_1 and FEV_1/ FVC ratio. These measurements by themselves provide a considerable amount of information about ventilatory function during normal and abnormal conditions.

Subjects

Pregnant women from the antenatal clinic of Government Hospital, Kilpauk Medical College, Chennai-10, were selected for this study. The study group consisted of 107 women, of which18 women in the first trimester; 20 women in the second trimester; 45 women in the third trimester; 24 women were in control group. For control group, subjects of same age group were recruited from the infertility clinic and Gynecology Out Patient Department. Those with no current respiratory signs or symptoms and no history of major respiratory illness were involved in the study. Measurements of lung functions were made after demonstration and explanation of the maneuvers to the subjects. Readings were recorded from the best of the three. No Corrections were made for BTPS. Lung functions studied were FVC, FEV_1, PEFR, FEF_{25-75} , $FEF_{25\%}$, $FEF_{50\%}$, & $FEF_{75\%}$

Technique

First the procedure of the maneuver was explained to the subjects, as proper understanding and co-operation was essential to obtain optimum values. The mouth piece was placed into the breathing tube. For FVC, the subject was instructed to take a maximal inspiration, the mouthpiece was placed firmly in the mouth and she was asked to breathe out maximally and rapidly till she was unable to expire anymore through the mouth piece.

Table Showing mean ± SD of different variables

Variables	First Trimester	Second Trimester	Third Trimester	Control
Age(yrs)	22 ± 2.99	23 ± 3.79	24 ± 3.53	29 ± 4.63
Height (cm)	153 ± 4.47	151 ± 5.20	152 ± 6.84	151 ± 6.35
Weight(Kg)	46 ± 7.96	46 ± 8.37	53 ± 8.09	47 ± 11.58
Chest expansion(cm)	3.3± 0.49	3.8 ± 0.52	3.5 ± 0.63	3.9 ± 0.68
Hb(gm)	10.5 ± 0.63	9.97 ± 0.52	9.87 ± 0.71	10.78 ± 0.64
FVC	1.91 ± 0.32	2.02 ± 0.25	1.90 ± 0.23	2.05 ± 0.23
FEV1	1.69 ± 0.23	1.74 ± 0.23	1.73 ± 0.23	1.73 ± 0.16
PEFR	4.19 ± 0.74	4.26 ± 0.67	3.82 ± 0.92	4.19 ± 0.94
FEF 25-75	3.18 ± 0.27	2.72 ± 0.40	2.78 ± 0.52	2.85 ± 0.32
FEF 25%	4.04 ± 0.72	3.97 ± 0.77	3.88 ± 0.72	3.88 ± 0.86
FEF 50%	3.61 ± 0.47	3.23 ± 0.64	3.16 ± 0.74	2.94 ± 0.80
FEF 75%	1.96 ± 0.37	1.70 ± 0.34	1.89 ± 0.51	1.63 ± 0.33

Maximal voluntary ventilation. The ability to reach a high MVV depends on the muscular forces available, on the compliance of the thoracic walls and lungs and on the airway resistance set up, MVV is profoundly reduced in patients with emphysema or in patients with airway obstruction. This computerized instrument gives data regarding percentage of prediction and also two tracings of Forced vital capacity – FVC; Maximum expiratory flow volume curve – MEFVC;

The maneuver was performed 2 to 3 times and the best of the reading for FVC was accepted. All the readings were obtained with the subject in the standing position.

RESULTS

The mean values with their standard deviations of individual variables for first trimester, second trimester, third trimester

and controls (Table 1) and Students t-test was applied to test the statistical significance to observe significant changes between two individual groups. We used the level of significance < 0.05 as Significant; < 0.01 as Highly Significant; < 0.001 as Very Highly Significant. (Table 2) (Figure 1)

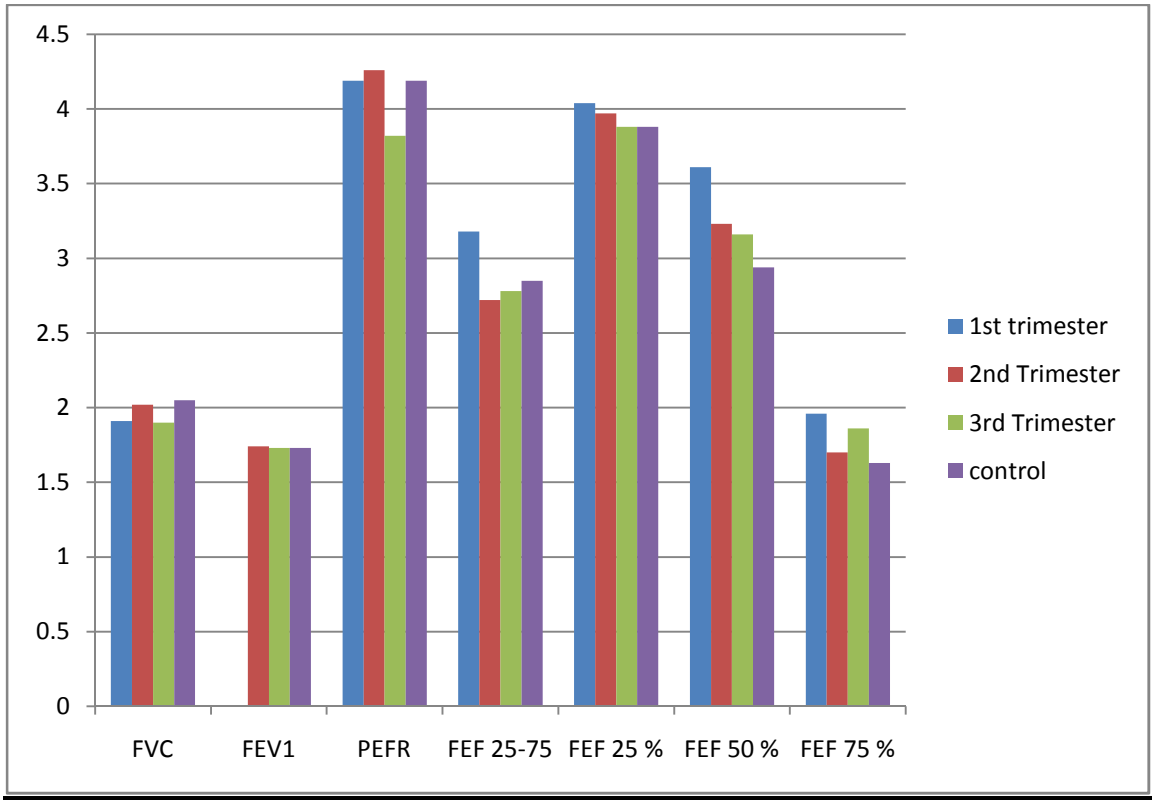

Figure 1.

Table 2. Comparison of First, Second, Third Trimesters, Control, with its 'P' Value

VARIABLES	FIRST & SECOND	SECOND & THIRD	FIRST & THIRD	FIRST & CONTROL	SECOND & CONTROL	THIRD & CONTROL
FVC	0.127	0.03	0.413	0.067	0.356	0.004
FEV1	0.227	0.397	0.265	0.255	0.41	0.482
PEFR	0.379	0.017	0.051	0.497	0.383	0.063
FEF 25-75	0.000	0.320	0.000	0.003	0.139	0.259
FEF 25%	0.372	0.346	0.216	0.246	0.358	0.481
FEF 50%	0.02	0.361	0.002	0.000	0.095	0.129
FEF 75%	0.015	0.044	0.271	0.002	0.223	0.005

In our study, values of FVC in all the three trimesters are less, when compared to controls. On comparing first and second trimester with control, the decrease in FVC values is not statistically significant. But on comparing third trimester with control, results showed highly significant. (Table 2) (Figure 1) There is slight reduction FEV, PEFR in pregnant women, but the change is significant only in third trimester. FEF $_{25-75}$ in first trimester shows statistically significant increase when compared to controls. The change in second and third trimester is insignificant. No significant change is observed is $FEF_{25\%}$ between controls and pregnant women. $FEF_{50\%}$ shows significant increase only in first trimester when compared to controls. $FEF_{75\%}$ also shows significant increase only in first and third trimester when compared to controls. (Table 2) (Figure 1) There is a significant increase in FVC, PEFR in second trimester when compared to third trimester. FEF_{25-75}, $FEF_{50\%}$, $FEF_{75\%}$ shows significant increase in first trimester when compared to second trimester. On comparing first and third trimester, $FEF_{50\%}$ alone shows significant increase in the first trimester. (Table 2) (Figure 1)

DISCUSSION

Pregnancy constitutes one of the most important states of physiological stress in human body. The gradually growing fetus, poses increasing metabolic demands on the mother, requiring delicate physiological adjustments in the circulation and respiration of the latter. The preservation of FVC is associated with diminished abdominal compliance and augmentation of ribcage volume displacement. Other contributory factors are relative mobility of thoracic cage as well as unimpaired diaphragmatic movement despite progressive enlargement of gravid uterus (Das *et al.,* 1991) Measures of large airway functions such as FVC, FEV_1 and PEFR were reduced during pregnancy and significantly so in the third trimester. This is in accordance with the study of Rupa Mokkapati *et al*. (Mokkapatti *et al.,* 1991).

The reduction in large airway function especially FVC in third trimester could be due to mechanical factors like enlarging uterus interfering with diaphragmatic excursions. Small Airway Function namely FEF_{25-75} is significantly higher in first than in controls, $FEF_{25\%}$, $FEF_{50\%}$ $FEF_{75\%}$ values are higher in all three trimesters when compared to control, but the changes are significant in second & third trimester. This is in accordance with the study of Gee *et al*. (1967) (Gee *et al.,* 1967). The increase in small airway function especially FEF_{25-75} could be due to smooth muscle relaxing effect of hormones like Progesterone, Relaxin and Corticosteroids. Progesterone is known for respiratory stimulant and is a major factor in the increased respiratory drive during pregnancy. The higher air flow during pregnancy may be due to an increase in the lumen of the airways and hence less resistance to the flow of air. It is suggested that during pregnancy there may be general pattern of smooth muscle relaxation which affects the tracheobronchial musculature. In addition, Progesterone, Relaxin and Adrenocortical hormones produce relaxation of the urinary, biliary and gastro intestinal smooth muscles. (Das *et al.,* 1991)

Conclusion

FEF_{25-75}, a small airway function showed a significant increase during pregnancy when compared to controls. The possible cause could be due to smooth muscle relaxing effects of Progesterone, Relaxin and Corticosteroids during pregnancy. Spirometric values though lower than those of the controls remained within physiological ranges throughout pregnancy. The changes in the maternal pulmonary function during pregnancy are adaptive in nature. In spite of the mechanical disadvantage to the respiratory apparatus, pregnant women are able to achieve adequate ventilation, which facilitates feto-maternal gas exchange.

Acknowledgement

We thank our dean, our professor and our subjects, who gave us full co-operation for conducting this work.

Conflict of Interest – Nil

Funding – self

Ethical Clearance- Obtained.

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